

**BEETLES ASSOCIATED WITH SLIME MOLDS (MYCETOZOA)  
IN OREGON AND CALIFORNIA  
(COLEOPTERA: LEIODIDAE, SPHINDIDAE, LATHRIDIIDAE)**

LOREN K. RUSSELL

Dept. of Entomology, Oregon State University, Corvallis, 97331

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Although the slime molds (Mycetozoa, or Myxomycetes) are an abundant and remarkably isolated group of organisms (Olive, 1975), there has been little recognition in the American literature of a beetle faunule adapted to feed on mycetozoan fruiting structures. This omission is likely due to most entomologists being unfamiliar with slime molds, which are often minute and often resemble certain types of true Fungi. The present paper records 11 species of beetles found by the author in four genera of slime molds in Oregon, and two beetle species found in two slime molds in California. This "guild" is compared with previously reported beetle associates of mycetozoans, principally those compiled from the European literature by Benick (1952).

Beetles have been collected in the following mycetozoans: *Fuligo septica* (Gmelin) and *Reticularia lycoperdon* (Ehrenb.), both occurring as massive compound sporangia (aethalia), and *Arcyria denudata* (L.) and *Stemonitis* spp., which occur as dense and sometimes extensive patches of stalked sporangia. *Lycogala epidendrum* (L.) has been cited as a host for *Sphindus* spp. in Europe, but I have found no beetles in two collections of this puff-ball-like species (Benton County, Oregon). Andrews (1977) has given the only published records of North American beetles from *Fuligo* and *Arcyria* and I have seen no American records for *Reticularia* as a host. Only a few definite records are available for beetles from other mycetozoan genera (Table 1).

Collections of *Fuligo* from widely separated Oregon localities have yielded 10 beetle species: *Sphindus crassulus* Csy. and *Odontosphindus clavicornis* Csy. (Sphindidae); *Enicmus cordatus* Belon (Lathridiidae); *Anisotoma confusa* Horn, *Anisotoma errans* Brown, *Anisotoma nevadensis* Brown, *Agathidium contiguum* Fall, *Agathidium pulchrum* LeC., *Agathidium brevisternum* Fall, and *Agathidium californicum* Horn (Leiodidae). As many as three species of beetles have been found in a single aethalium. These collections include the first Oregon records for the family Sphindidae. (Collection records are listed separately below.)

Most of the *Fuligo* associated beetles were found in mature, dry aethalia,

Table 1. Previously reported and new records of beetles associated with slime-molds.

Beetle	Beetle family	Slime mold <sup>1</sup>	Slime mold family <sup>1</sup>	Reference
1. <i>Oxytelus tetracarınatus</i> (Block)	Staphylinidae	<i>Reticularia olivacea</i> (Ehrenburg)	Reticulariidae	Benick (1952)
2. <i>Xantholinus punctulatus</i> Paykull	Staphylinidae	<i>R. olivacea</i>	Reticulariidae	Benick
3. <i>Quedius cruentus</i> (Olivier)	Staphylinidae	<i>R. olivacea</i>	Reticulariidae	Benick
4. <i>Q. mesomelinus</i> (Marshall)	Staphylinidae	<i>R. olivacea</i>	Reticulariidae	Benick
5. <i>Philonthus fimetarius</i> (Gravenhorst)	Staphylinidae	<i>R. olivacea</i>	Reticulariidae	Benick
6. <i>Atheta amıcula</i> (Stephens)	Staphylinidae	<i>R. olivacea</i>	Reticulariidae	Benick
7. <i>A. aterrima</i> (Gravenhorst)	Staphylinidae	<i>R. olivacea</i>	Reticulariidae	Benick
8. <i>A. fungicola</i> (Thomson)	Staphylinidae	<i>R. olivacea</i>	Reticulariidae	Benick
9. <i>A. inoptata</i> (Sharp)	Staphylinidae	<i>R. olivacea</i>	Reticulariidae	Benick
10. <i>A. oblita</i> (Erichson)	Staphylinidae	<i>R. olivacea</i>	Reticulariidae	Benick
11. <i>Bacanius rhombophorus</i> Aube	Histeridae	<i>Fuligo septica</i> (Linne)	Physaridae	Benick
12. <i>Agathidium confusum</i> Bristol	Leiodidae	<i>Reticularia lycoperdon</i> (Bullard)	Reticulariidae	Benick
13. <i>A. rhinoceros</i> Sharp	Leiodidae	<i>R. lycoperdon</i>	Reticulariidae	Benick
14. <i>A. seminulum</i> (Linne)	Leiodidae	<i>Arcyria denudata</i> (Linne)	Trichiidae	Benick
		<i>Fuligo septica</i>	Physaridae	Benick
		<i>Reticularia lycoperdon</i>	Reticulariidae	Benick
15. <i>A. sphaerula</i> Reitter	Leiodidae	<i>Arcyria denudata</i> <sup>2</sup>	Trichiidae	Benick
		<i>Reticularia lycoperdon</i>	Reticulariidae	Benick
16. <i>A. pulchrum</i> LeConte	Leiodidae	<i>Stemonitis</i> sp.	Stemonitidae	Hatch (1957)
		<i>Fuligo septica</i>	Physaridae	PRESENT PAPER
		<i>Arcyria denudata</i>	Trichiidae	PRESENT

Table 1. Continued.

Beetle	Beetle family	Slime mold <sup>1</sup>	Slime mold family <sup>1</sup>	Reference
17. <i>A. rotundulum</i> Mannerheim	Leiodidae	<i>A. denudata</i>	Trichiidae	PRESENT
18. <i>A. californicum</i> Horn	Leiodidae	<i>Fuligo septica</i>	Physaridae	PRESENT
19. <i>A. brevisternum</i> Fall	Leiodidae	<i>F. septica</i>	Physaridae	PRESENT
20. <i>A. contiguum</i> Fall	Leiodidae	<i>F. septica</i>	Physaridae	PRESENT
21. <i>Amphicyllis globiformis</i> Sahlberg	Leiodidae	slime mold	?	Benick
22. <i>Anisotoma axillaris</i> Gyllenhal	Leiodidae	<i>Reticularia lycoperdon</i>	Reticulariidae	Benick
23. <i>A. castanea</i> Herbst	Leiodidae	<i>R. lycoperdon</i>	Reticulariidae	Benick
		<i>Fuligo septica</i>	Physaridae	Benick
24. <i>A. glabra</i> Kugel	Leiodidae	slime mold	?	Benick
25. <i>A. humeralis</i> Fabricius	Leiodidae	<i>Reticularia lycoperdon</i>	Reticulariidae	Benick
26. <i>A. orbicularis</i> Herbst	Leiodidae	<i>R. lycoperdon</i>	Reticulariidae	Benick
27. <i>A. confusa</i> Horn	Leiodidae	<i>Fuligo septica</i>	Physaridae	PRESENT
28. <i>A. errans</i> Brown	Leiodidae	<i>F. septica</i>	Physaridae	PRESENT
29. <i>A. nevadensis</i> Brown	Leiodidae	<i>F. septica</i>	Physaridae	PRESENT
30. <i>Thymalus limbatus</i> (Fabricius)	Ostomidae	<i>Reticularia lycoperdon</i>	Reticulariidae	Benick
31. <i>Reveliera californica</i> Fall	Lathridiidae	<i>Arcyria versicolor</i> Phillips	Trichiidae	Andrews (1977)
32. <i>Enicmus cordatus</i> Belon	Lathridiidae	<i>Fuligo septica</i>	Physaridae	PRESENT
		<i>Stemonitis</i> sp.	Stemonitidae	Hatch, PRESENT
33. <i>E. tenuicornis</i> LeConte	Lathridiidae	<i>Stemonitis axifera</i> (Bullard)	Stemonitidae	PRESENT
34. <i>E. fungicola</i> Thomson	Lathridiidae	<i>Reticularia lycoperdon</i>	Reticulariidae	Benick
35. <i>E. rugosus</i> (Herbst)	Lathridiidae	<i>Fuligo septica</i>	Physaridae	Benick
		<i>Reticularia lycoperdon</i>	Reticulariidae	Benick

Table 1. Continued.

Beetle	Beetle family	Slime mold <sup>1</sup>	Slime mold family <sup>1</sup>	Reference
36. <i>E. testaceus</i> (Stephens)	Lathridiidae	<i>R. lycoperdon</i>	Reticulariidae	Benick
37. <i>C. consimilis</i> (Mannerheim)	Lathridiidae	slime mold	?	Benick
38. <i>E. hirtus</i> Gyllenhal	Lathridiidae	slime mold	?	Benick
39. <i>E. minutus</i> (Linne)	Lathridiidae	slime mold	?	Benick
40. <i>Lathridius nodifer</i> Westwood	Lathridiidae	slime mold	?	Benick
41. <i>Aspidophorus lareyniei</i> Duval	Sphindidae	slime mold	?	Benick
42. <i>A. orbiculatis</i> Gyllenhal	Sphindidae	<i>Reticularia lycoperdon</i>	Reticulariidae	Benick
43. <i>Odontosphindus clavicornis</i> Casey	Sphindidae	<i>Fuligo septica</i>	Physaridae	Andrews, PRESENT
		<i>Stemonitis</i> sp.	Stemonitidae	Hatch (1962)
44. <i>O. denticollis</i> (LeConte)	Sphindidae	slime mold (?)	?	Frost (1947) <sup>3</sup>
45. <i>Sphindus crassulus</i> Casey	Sphindidae	<i>Fuligo septica</i>	Physaridae	PRESENT
46. <i>S. dubius</i> Gyllenhal	Sphindidae	<i>Lycogala epidendrum</i> (Linne)	Liceidae	Benick
		<i>Fuligo septica</i>	Physaridae	Benick
		<i>Reticularia lycoperdon</i>	Reticulariidae	Benick
47. <i>S. grandis</i> Hampe	Sphindidae	slime mold	?	Benick
		<i>Lycogala</i> sp.	Liceidae	Crowson (1955)

<sup>1</sup> The nomenclature used is after Martin and Alexopoulos (1969), but names are given according to zoological usage, as in Olive (1975).

<sup>2</sup> Benick gives this host as *Trichia cinnabara*, a synonym of *Arcyria denudata* (Martin and Alexopoulos, 1969).

<sup>3</sup> Frost does not cite this as a slime mold; this interpretation is highly likely from his description.



but the *Anisotoma* species have been taken more frequently in moist specimens which were transforming from the plasmodial phase. The lathridiids and sphindids were found throughout the powdery spore-bearing tissue of aethalia which varied in size from 3 cm to 10–15 cm diameter. The *Fuligo* specimens lacked evident entrance holes, which suggests that most of the beetles had developed *in situ*. Two lathridiid larvae were found with *E. cordatus* in 1 sample of *Fuligo*, and larvae and pupae of *O. clavicornis* were dissected from another *Fuligo* specimen. No insects other than the beetles mentioned were observed in any samples of *F. septica*.

*Stemonitis* spp. have also yielded both adults and larvae of *Enicmus*. Twenty-two adult *E. tenuicornis* LeC. were collected from a 3 cm wide patch of *Stemonitis axifera* (Bull.) under loose bark of a *Lithocarpus* log in Amador County, California. Several larvae were found with the adult *E. tenuicornis* and two were reared to the adult stage. Many *E. cordatus* were taken from a *Stemonitis* (species indet.) under oak bark in Benton County, Oregon.

A large collection of *Arcyria denudata* (L.) found on the Oregon coast in November, yielded adults of *Agathidium pulchrum* LeC. and *Agathidium rotundulum* Mann., as well as *Agathidium* larvae on and among the sporangia. Two *Agathidium rotundulum* adults were reared from larvae in this collection. A second collection of *Arcyria denudata* from near San Bernardino, California contained three adult *Agathidium pulchrum*.

Of the 12 beetle species listed above, only *Agathidium pulchrum* is known to be a general fungivore; I have found adults and larvae of this species in Oregon on the "oyster mushroom," *Pleurotus ostreatus* group, and on a jelly fungus, *Tremella mesenterica* (S. F. Gray) Pers., both of which are Basidiomycetes. I have also seen a specimen of *Agathidium pulchrum* labelled "on slime mold plasmodium" from King County, Washington (D.V. McCorkle, collector). *Enicmus cordatus* has been recorded from *Neotoma* nest, under bark, and in willow duff (Hatch, 1962), but it is my view (supported by F. G. Andrews, personal communication) that Mycetozoa are the usual breeding substrate for this species and perhaps for all *Enicmus* species in western North America. *Odontosphindus clavicornis* has been collected from the slime mold *Stemonitis* sp. in British Columbia (Hatch, 1962), and Andrews (1977) also records it from *Arcyria versicolor* Phill. and *F. septica* in California; no useful host records are available for the other beetle species above. *Agathidium rotundulum* and *Agathidium brevisternum* are relatively abundant in Berlese extracts from forest litter and may also be general fungivores; since *Anisotoma* spp. and the sphindids are rarely encountered except in flight (including light-trap collections), their occurrence in mycetozoans as reported here is likely to be obligatory. All the beetles listed here are related to beetles in Europe which are indicated as slime mold specialists (Benick, 1952).

### Comparison with Known Insect Associates of Mycetozoa

The only available faunal area to compare with these West Coast slime mold beetles is Europe. There, as in North America, the best-documented association of a beetle taxon with Mycetozoa is for the Sphindidae. Benick (1952) lists four species of *Sphindus* and *Aspidophorus* from mycetozoans of the genera *Lycogala* and *Reticularia* (but also, less frequently from a few polypore and agaric fungi among the Basidiomycetes). Crowson (1955) stated that both British genera (*Sphindus*, *Aspidophorus*) "as far as known, feed exclusively on Mycetozoa."

In contrast, most American authors have characterized the Sphindidae as "dry-fungus beetles." Arnett (1963) for instance, indicates their habitat as being "in dry fungi, mostly shelf fungi on tree trunks and old logs." Aside from Hatch's (1962) record of *Odontosphindus clavicornis* on the slime mold *Stemonitis*, the only interpretable American host records for sphindids are those of Frost (1947) of *Sphindus americanus* in association with cisd species on "small, crowded, woody fungi," which may be the basidiomycete *Polyporus versicolor* or a similar species, and of *Odontosphindus denticollis* (LeC.) (as *Eurysphindus denticollis*) in a "flat, brown fungus of a soft smut-like consistency." The latter description is rather obviously of a mycetozoan. The usual occurrence of *O. clavicornis* in slime molds, and my single record of *Sphindus crassulus* in *Fuligo* further increase the probability that this host association is usual, if not exclusive, in the Sphindidae. While observations of sphindids apparently feeding on polypore fungi cannot be completely discounted, they may have been confounded by the frequent occurrence of mycetozoan plasmodia in old polypore sporocarps (Martin and Alexopoulos, 1969). The common application of the term "polypore" to almost any dry or woody sporocarp also makes acceptance of such records questionable.

The other genera of beetles reported here from slime molds are also probable mycetozoan specialists. All of the seven species of *Anisotoma* and six species of *Enicmus* in Benick's list of European mycophagous beetles have been reported from slime molds. In most cases this is the usual or exclusive substrate, although *Enicmus* species are rather often cited from hosts among the true Fungi. Benick also reported four of 19 listed species of *Agathidium* from slime molds; the host restrictions in this genus vary at the species level. Of the European beetle genera commonly cited from mycetozoan hosts, only *Amphicyllis* (Leiodidae) is missing from my collections; this genus does not occur in North America.

Although I found different species on *Fuligo* and on *Arcyria*, there is no good evidence of specialization on particular mycetozoan hosts. In part I have observed a seasonal effect, for *Enicmus* and the Sphindidae are evidently adapted to very xeric conditions, while the Leiodidae require more moisture, and are (in the Pacific Northwest) more typically active in cool,

moist weather. The aethalia containing *Anisotoma* and *Agathidium* were usually located in moist sites under bark or on the surface in deep shade, while *Enicmus* and *Odontosphindus* were often found in very exposed sites. The mycetozoans listed as hosts in Table 1 belong to four of the five orders of Myxogastria (the true slime molds) recognized by Oliver (1975); it is likely that all slime mold sporangia of sufficient size are subject to attack by beetles.

It is probable that most or all of the Coleoptera specializing on mycetozoans feed on the spores; Andrews (1977) has found this to be the case for the lathridiid *Reveliera californica* Fall. The basis for the differentiation of Mycetozoa as a coleopteran food-niche may be nutritional, or be related to the rapid desiccation of the slime mold. The slime mold fauna is clearly derived from mycophagous taxa, even though the Mycetozoa are best regarded as colonial Protozoa not directly related to the true Fungi (Olive, 1975). It is interesting to note that this speciality can be observed among the Coleoptera at the family (Sphindidae), genus (*Anisotoma*, *Enicmus*), and species (*Agathidium*, in part) taxonomic levels.

Aside from beetles the Diptera appear to be the only important insect associates of slime molds. Buxton (1954) bred 16 species of flies, representing 10 families, from mycetozoans. These included several apparent slime mold specialists, as well as a number of common saprozoic species which feed on rotting plasmodia. The absence of fly-infested material from my collections presumably accounts for the lack of predatory, mycetophilous staphylinids in my list, in contrast to those cited by Benick (1952).

### Collection Data

#### *Fuligo septica* (Gmelin)

Oregon: Benton County. a) MacDonald State Forest, VII-18-75, Loren Russell Collector. 1 aethalium on Douglas fir stump: *Odontosphindus clavicornis* Csy. (10 specimens), *Sphindus crassulus* Csy. (1), *Enicmus cordatus* Bel. (14). Many beetles escaped. b) Marys Peak, 610 m elevation, V-8-77, Loren Russell. 1 aethalium on small branch: *Anisotoma errans* Brown (5). c) Marys Peak, 610 m, V-3-88, Loren Russell. 1 moist aethalium on stump. *Agathidium pulchrum* LeConte (1), *Agathidium brevisternum* Fall (1).

Marion County. Mt. Jefferson Wilderness Area, 10 km SE Breitenbush Hot Springs, 600 m, VIII-24-75, Bill Frost. 1 moist aethalium on Douglas fir stump: *Anisotoma confusa* Horn (12).

Jefferson County. a) 8 km N Suttle Lake, 930 m, VIII-9-75, Loren Russell. 3 aethalia on ponderosa pine litter on old log: *O. clavicornis* (38 adults, 5 pupae, 2 larvae), *E. cordatus* (3), *Anisotoma errans* Brown (2). b) Metolius River area, 900–950 m, V-28-76, Loren Russell and P. J. Johnson. Aethalia under bark of ponderosa pine stumps: *O. clavicornis* (7), *E. cordatus* (3),



*Anisotoma confusa* (4). c) Dark Lake, IX-14-77, G. L. Peters. Several aethalia. *O. clavicornis* (1), *E. cordatus* (5), *Agathidium contiguum* Fall (47), unidentified leioidid (2).

Crook County. Bandit Springs Wayside, 1 km SW Ochoco Summit, 1380 m, V-29-76, P. J. Johnson. 1 aethalium under pine bark: *Anisotoma confusa* (2), *Agathidium californicum* Horn (1).

Wheeler County, Ochoco Divide Campground, 1350 m, VII-16-77, Loren Russell. 2 fresh aethalia on Douglas fir log: *Anisotoma nevadensis* Brown (14), *Agathidium contiguum* (4), *O. clavicornis* (43).

Klamath County. Lake of the Woods, 1500 m, VII-20-75, Loren Russell. 5 small aethalia on pine litter: *E. cordatus* (34).

#### *Reticularia lycoperdon* (Ehrenb.)

Oregon: Crook County. Maury Mtns., Drake Butte, 1890 m, VII-25-76, Loren Russell. 1 old eroded aethalium, 1 fresh aethalium on cut surface of pine stump: *E. cordatus* (18).

#### *Arcyria denudata* (L.)

Oregon: Tillamook County. Cascade Head, Nature Conservancy Trail, XI-21-75, Loren Russell. One 30 × 5 cm patch of eroded sporangia on side of red alder log: *Agathidium pulchrum* (3), *Agathidium rotundulum* Mannerheim (1 adult, 2 others reared from larvae on this sample).

Linn County. 5 km SE Jordan, VII-2-77, Loren Russell. In moist cavity of rotted maple stump: *Agathidium pulchrum* (7).

California: Los Angeles County. Mt. San Antonio, IV-27-76, Loren Russell. Small patch of sporangia on log buried in river bar: *Agathidium pulchrum* (3).

#### *Stemonitis axifera* (Bull.)

California: Amador County. 2 km E Jackson, V-4-76, Loren Russell. 3 cm patch of sporangia under loose bark of *Lithocarpus*: *Enicmus tenuicornis* LeConte (22 adults, several larvae).

#### *Stemonitis* sp. indet.

Oregon: Benton County. a) MacDonald State Forest, VIII-21-76, G. L. Peters. Under bark of oak log: *E. cordatus* (18). b) Same locality and host, VI-26-77 Loren Russell *E. cordatus* (3).

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### Literature Cited

- Andrews, F. G. 1977. A new species of *Fuchsina* Fall with notes on some California Lathridiidae. Pan-Pac. Entomol. 52: 339-347.
- Arnett, R. H., Jr. 1963. The beetles of the United States. Catholic Univ. of America Press, Washington, D.C. xii + 1112 pp.
- Benick, L. 1952. Pilzkafer und Kaferpilze. Acta Zool. Fenn. 70: 1-250.
- Buxton, P. A. 1954. British Diptera associated with fungi. 2. Diptera bred from Myxomycetes. Proc. Roy. Entomol. Soc. Lond. (A) 29: 163-171.
- Crowson, R. A. 1955. The natural classification of the families of Coleoptera. Nathaniel Lloyd, London. 187 pp.
- Frost, C. A. 1947. Sphindidae and Cisidae. Psyche 54: 180.
- Hatch, M. H. 1957. The beetles of the Pacific Northwest. Part II. Staphyliniformia. Univ. of Washington Press, Seattle. iv + 384 pp.
- Hatch, M. H. 1962. The beetles of the Pacific Northwest. Part III. Pselaphidae and Diversicornia I. Univ. of Washington Press, Seattle. ix + 503 pp.
- Martin, G. W., and C. J. Alexopoulos. 1969. The Myxomycetes. Univ. of Iowa Press, Iowa City. 560 pp.
- Olive, L. S. 1975. The Mycetozoans. Academic Press, New York. 293 pp.